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3

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13. ABSTRACT

Recordings of several directionally selective motion detectors were made in the optic lobe. Object wavelength and velocity relationships were determined and compared with optomotor response and it was concluded these neurons were part of the neural system underlying flight control. Spectral sensitivity measurements were then made on these units to determine how the system is organized to distinguish color. It was found that these units receive information from all described photopigments but do not distinguish color. Hence, the color channel and movement channel are separate which is surprising in the context of economy of neuron and in knowledge of neuroanatomy. Two papers have been published as a result of this research.

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4

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Introduction:

This project is concerned with the encoding of sensory information by the nervous system. The approach is to record slow potentials or the activities of single neurons in response to stimuli that are meaningful to the animal in his natural habitat. The choice of animal is important.

As originally conceived, the mantis shrimp (Pseudosquilla) was to be used since it has prey tracking and strike capability. However, the project took a different direction for two reasons:

1. Mantis shrimps were not available. Efforts were made to obtain these animals from our marine laboratory facility on Catalina Island, from the local professional collectors who had supplied previous investigators, and from the California Department of Fish and Game. Efforts were also made to obtain pseudosquilla (and relatives) from collectors in Florida. All of these efforts failed in the long run. In the meantime preliminary experiments were performed upon other crustacea. Recently divers at Catalina have observed mantis shrimps. The original project will be pursued if collection of the animals is feasible.

2. The project was expanded to a larger and more general effort, so that part of the effort during this time period was devoted to planning and construction of equipment for the follow-on effort.

Research performed:

The experiments performed fall into two categories: 1) Preliminary experiments on crustacea during the period collection of mantis shrimps was attempted, and 2) experiments upon the motion-detecting system of the honeybee.

1. Crustacean experiments: In order to develop recording techniques for mantis shrimps, experiments were performed on the galatheid shrimp Pleuroncodes planipes. Recordings were made from the optic nerve in the eye stalk using etched tungsten electrodes. Difficulty was encountered in immobilizing the eyestalk. A dental impression material (Algenate) was used. The following classes of response observed are shown in Figure 1. As expected from the works of other investigators, the eyestalk of crustaceans is a neurologically active area that is accessible by standard recording techniques.

2. Honeybee experiments: The honeybee is a remarkably good subject for the study of neural correlates of behavior since it has a rich behavior and two usable morphological types. Efforts were expended to study the flight control system and the color discrimination system of this animal.

During the time period of this grant recordings of several directionally selective motion detectors were made in the optic lobe. The honeybee has a system of four classes of neurons, each is excited maximally from a spontaneous rate by movement of an object in one direction and inhibited from a spontaneous rate by movement of an object in a direction 180 degrees from the maximally excitatory direction. The response varies as the cosine of the angle from the maximum direction. These units form an orthogonal set. Object wavelength and velocity relationships were determined and compared with the flying response (optomotor response) and it was concluded that these neurons were part of the neural system underlying the control of flight. Spectral sensitivity measurements were then made upon these units in the hope that it would give some information as to how this system is organized to distinguish color. It was found that these units receive information from all of the photopigments described by previous investigators and that these units do not distinguish color. Hence, the color channel and the movement channel are separated in this animal as I found it to be in other insects, such as flies. This is surprising in the context of the economy of neuron use in insects and in the context of what is known about the neuroanatomy. Two papers were published on these results.

Publications:

1. Directionally selective motion detecting units in the optic lobe of the honeybee. Z. vergl. Physiol. 67: 403-413 (1970), (with W. Kaiser).
2. The spectral sensitivity of motion detector units recorded in the optic lobe of the honeybee. Z. vergl. Physiol. 70: 374-381 (1970).

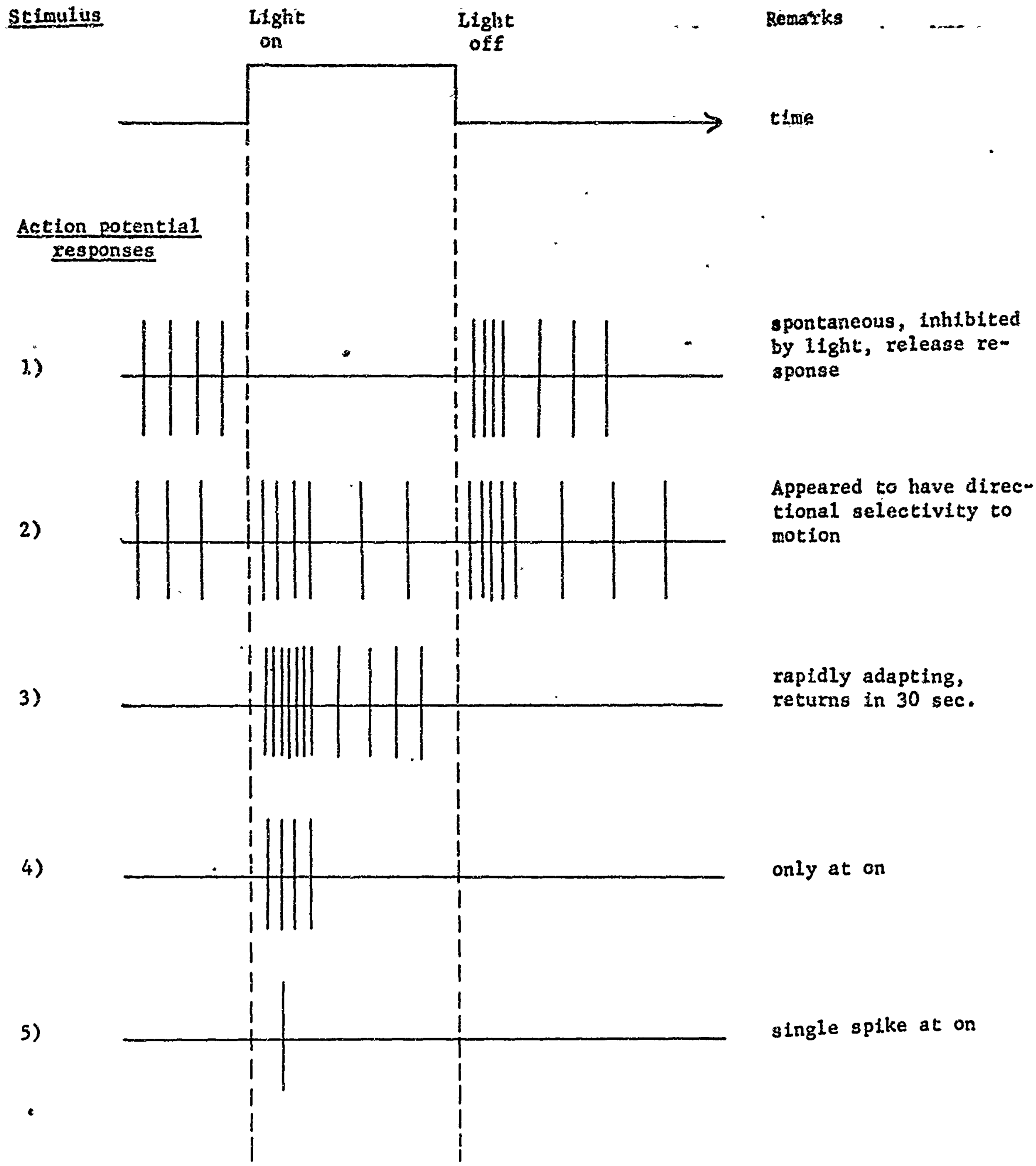

Figure 1. Single unit responses from the optic lobe of the shrimp <u>Pleuroncodes planipes</u>.